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Population Structure of Blood Cockle (*Anadara antiquata*) in the Intertidal Zone of Sinaboi Coastal Waters, Rokan Hilir

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ABSTRACT

Blood cockle (*Anadara antiquata*) is one of the benthic organisms commonly found in intertidal ecosystems and has important ecological and economic roles in coastal areas. Information regarding its population condition is needed to support sustainable resource management. This study aimed to analyze the population structure of *A. antiquata* in the intertidal zone of Sinaboi coastal waters, Rokan Hilir. This research was conducted in October 2025 in the coastal waters of Sinaboi, Rokan Hilir. Sample analysis was carried out at the Marine Biology and Physical Oceanography Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Science, Universitas Riau. The study used a survey method through direct observation, measurement of environmental parameters, and sampling. Sampling was conducted using purposive sampling across three intertidal subzones: lower, middle, and upper. The results showed that environmental parameters ranged from 30–32°C for temperature, 30‰ for salinity, 7 for pH, and 7–8 cm for water transparency. The sediment type was muddy with organic matter content ranging from 7.66–14.66%. The highest abundance of *A. antiquata* was found in the lower subzone (60,000 ind/ha), while the lowest was in the middle subzone (46,000 ind/ha). Statistical analysis indicated no significant difference in abundance among subzones ($p > 0.05$). Shell size ranged from 18.1–57.4 mm and was dominated by small and medium size categories.

Keywords: *Anadara antiquata*, Abundance, Distribution pattern, Intertidal zone

1. INTRODUCTION

The intertidal zone is a dynamic coastal ecosystem characterized by periodic environmental fluctuations caused by tidal cycles. These fluctuations require organisms inhabiting this area to adapt to variations in temperature, salinity, substrate type, and the availability of organic matter. Molluscan communities, particularly Bivalvia and Gastropoda, constitute important components of intertidal ecosystems, playing significant roles in food webs and serving as bioindicators of environmental conditions (Abdillah & Karnan, 2019). One of the economically important bivalve species found in intertidal areas is the blood cockle (*Anadara antiquata*). Coastal communities widely use this species as a source of protein and for fisheries. In addition to its economic value, *A. antiquata* offers significant nutritional benefits, including essential amino acids and fatty acids that support human health (Abdullah et al., 2013). Ecologically, this species inhabits muddy to muddy-sandy substrates, making its distribution and abundance highly dependent on the physical and chemical characteristics of the sediment and surrounding waters.

Environmental changes such as increased sedimentation, fluctuations in organic matter content, and variations in nutrient concentrations (e.g., nitrate and phosphate) may significantly influence the growth, abundance, and spatial distribution of bivalve populations. Previous studies have shown that the abundance and distribution patterns of intertidal bivalves are closely related to habitat characteristics, particularly substrate type and conditions within the mangrove ecosystem (Abdurrahman et al., 2017). These findings highlight the strong relationship between population structure and environmental factors.

The coastal waters of Sinaboi, Rokan Hilir Regency, represent one of the potential habitats for *A. antiquata*. However, increasing exploitation pressure, including harvesting without regard for size, age, or reproductive season, as well as overexploitation, may threaten the sustainability of its population. Scientific information regarding the population structure of *A. antiquata* in this area remains limited, particularly concerning abundance, distribution patterns, and shell size distribution. Such information is essential for supporting sustainable resource management.

Population structure analysis is a crucial approach for assessing the condition of biological resources. Abundance reflects the level of population availability within a habitat, distribution patterns indicate ecological adaptation strategies, and shell size distribution provides insights into growth conditions and recruitment potential. Therefore, investigating the population structure of *A. antiquata* is fundamental to developing science-based, sustainable management strategies.

Based on these considerations, this study aims to analyze the population structure of *Anadara antiquata* in the intertidal zone of Sinaboi coastal waters by assessing abundance, distribution patterns, and shell size distribution. The results of this study are expected to provide updated scientific information to support sustainable management and utilization of blood cockle resources in the coastal area of Rokan Hilir.

2. RESEARCH METHOD

Time and Place

This research was conducted in October 2025 in the intertidal waters of Sinaboi, Rokan Hilir Regency, Riau Province, Indonesia. Field sampling, environmental parameter measurements, and specimen collection were carried out directly at the study site. Laboratory analyses were conducted at the Marine Biology and Physical Oceanography Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Science, Universitas Riau.

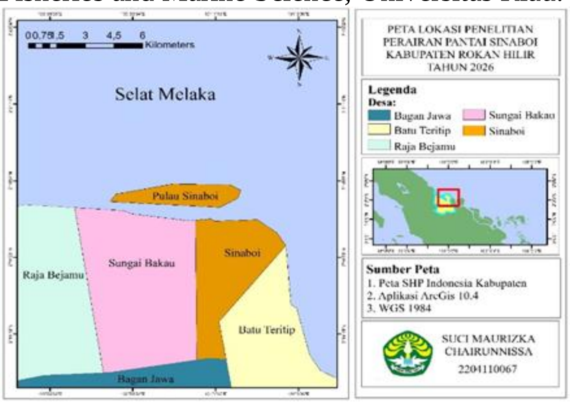

Figure 1. Research Location Map

Method

This study employed a survey method combined with direct field observation. Sampling was conducted using a purposive sampling technique based on habitat characteristics within the intertidal zone. Three subzones were designated as sampling stations: the upper, middle, and lower intertidal areas.

Data collection consisted of primary and secondary data. Primary data included measurements of environmental parameters, including temperature, salinity, pH, water transparency, sediment type, and organic matter content. In addition, samples of *A.antiquata* were collected using quadrat transects to determine abundance, distribution pattern, and shell length distribution.

Abundance was calculated as the number of individuals per unit area and converted to individuals per hectare (ind/ha). Distribution patterns were analyzed using dispersion indices to determine whether they were random, uniform, or clumped. Shell length measurements were conducted using a caliper to the nearest millimeter to analyze the size frequency distribution. Secondary data included supporting information on the general condition of the Sinaboi coastal waters, obtained from relevant literature and local government reports.

Procedures

Determination of Station Locations

Sampling stations were determined using a purposive sampling method based on habitat characteristics within the intertidal zone of Sinaboi waters. Three stations were established to represent different intertidal subzones: Station I: Lower Intertidal Zone; Located closest to the sea and submerged for the longest duration during high tide. The substrate was predominantly muddy sediment.

Station II: Middle Intertidal Zone; Situated in the transitional area with relatively balanced periods of inundation and exposure. The substrate consisted of muddy sand. Station III: Upper Intertidal Zone; Located in the area least frequently inundated and more often exposed during low tide. This station was relatively closer to coastal community activities, with muddy substrate and higher organic matter content.

Sediment Sample Analysis for Organic Matter as a Determinant of Sediment Type

Sediment samples were collected from the sediment surface at the same locations, approximately 500 g per subzone. Sampling was conducted in triplicate for each plot. Samples were stored in labeled plastic bags and kept in an ice box before laboratory analysis.

Grain size analysis was performed using the wet sieving and pipette methods. Before analysis, sediment samples were oven-dried at 105°C until constant weight, cooled in a desiccator, and soaked in a 3–5% H_2O_2 solution to remove salts from sediment particles.

Measurement of Sediment Organic Matter Content

The organic matter content was calculated using the Loss on Ignition (LOI) method based on Mucha et al. in Abdurrahman et al. (2017), as follows:

$$\text{Organic material} = \frac{a-c}{a-b}\ 100\%$$

Description:

- a = weight of crucible and sediment sample before ignition/after drying (g)
- b = weight of empty crucible (g)
- c = weight of crucible and sediment sample after ignition (g)

Abundance of *A. antiquata*

The abundance of *A. antiquata* was calculated as the number of individuals per unit area (ind/m²) following Odum (1993), using the formula:

$$K=\frac{N}{A}$$

Description:

- K = species abundance (ind/m²)
- N = number of individuals observed (ind)
- A = plot area (m²)

Distribution Pattern of *A. antiquata*

The distribution pattern of *A. antiquata* was determined using Morisita's Dispersion Index following Brower et al. in Abdurrahman et al. (2017), using the formula:

$$ID = \frac{n\left(\sum x^2 - n\right)}{N\ (N-1)}$$

Description:

- Id = Morisita's dispersion index
- N = number of plots
- n = total number of individuals (ind)
- $\sum x^2$ = sum of squared individuals per plot

Distribution criteria**:** Id > 1 clumped distribution; Id = 1 random distribution; Id < 1 uniform distribution.

Shell Size Distribution of *A. antiquata*

In this study, shell length was grouped into three size classes: Class I (small), Class II (medium), and Class III (large). The class interval was determined using the following formula:

$$c=\frac{j}{k}$$

Description:

- c = shell length class interval
- j = range
- k = number of class intervals (3)

Data Analysis

The obtained data were presented in tables and graphs and analyzed descriptively. The abundance and distribution of *A. antiquata* were processed using Microsoft Excel. Differences in the abundance of *A. antiquata* among intertidal zones were analyzed using the One-Way ANOVA statistical test.

3. RESULT AND DISCUSSION

Water Quality Parameters

The measured parameters included temperature, salinity, pH, water transparency, sediment type, and organic matter. The average results of water quality measurements in the Sinaboi waters are presented in Table 1.

Table 1. Water Quality

Parameter	Sampling Points			Mean
	Lower	Middle	Upper	
Temperature (˚C)	31	30	32	31
Salinity (‰)	30	30	30	30
pH	7	7	7	7
Transparancy (cm)	7	8	7	7,3

Table 1, each subzone shows variation in values and reflects conditions that are still within the normal range for bivalve life. The measured water temperature ranged from 30 to 32 °C with an average of 31 °C. This is consistent with Noris (2021), who stated that this temperature range is suitable for bivalves because the optimal temperature for aquatic organisms is

25–35 °C. The salinity obtained in this study was around 30‰. This value is still appropriate for mollusks, as they can live well within a salinity range of 24–40‰ (Bua, 2018). The average pH value of the Sinaboi waters was 7, which is considered suitable for supporting bivalve life because the ideal pH range for bivalves is 5.8–8.3 (Samson & Kasale, 2020). Meanwhile, water transparency ranged from 7 to 8 cm with an average of 7.3 cm.

Sediment Organic Matter

Based on the results of sediment organic matter analysis conducted on all samples across the subzones, the findings can be seen in Table 2.

Table 2. Sediment Organic Matter Content in the Waters of Sinaboi Beach

Subzone	Organic matter content (%)	Mean matter (%)	organic content
Upper	48,15	9,63	
Middle	38,3	7,66	
Lower	73,31	14,66	

Based on Table 2, sediment organic matter content varies across the research subzones. The average organic matter content ranged from 7.66 to 14.66%. The highest organic matter content was found in the lower subzone with an average of 14.66%, while the lowest was recorded in the middle subzone with an average of 7.66%.

Abundance of *A. antiquata*

The results showed differences in the abundance of blood cockle (*A. antiquata*) among the intertidal subzones of Sinaboi coastal waters The lower subzone exhibited the highest abundance, averaging 60,000 ± 24,500 ind/ha, indicating that it represents the most suitable habitat for *A. antiquata* (Figure 2). The highest abundance observed in the lower subzone is likely related to the dominance of finer mud fractions and more stable substrate conditions due to longer inundation periods. Muddy substrates are generally more suitable for bivalves because they facilitate burrowing and tend to accumulate organic matter as a food source. In contrast, although the middle and upper subzones also consisted of muddy sediment, slight variations in the sand and gravel fractions may influence substrate stability and individual distribution. However, because the sediment type across all subzones still falls within the mud category, these differences were not sufficiently pronounced to produce statistically significant differences in abundance ($p > 0.05$).

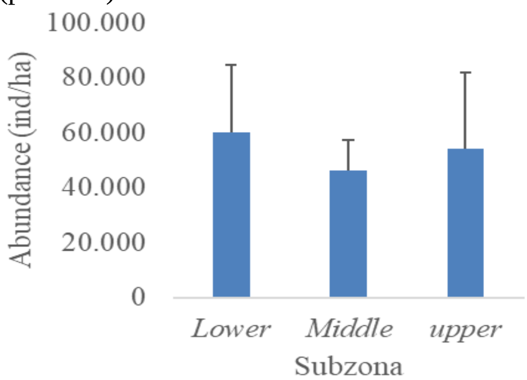

Figure 2. Abundance of blood cockle (*A. antiquata*) in the intertidal subzones of Sinaboi coastal waters

The lowest abundance of *A. antiquata* was recorded in the middle subzone, with 23 individuals and a mean abundance of 46,000 ind/ha. This condition is presumed to be related to the proximity of this area to human activities, particularly harvesting by local fishers. High harvesting pressure can reduce population density in exploited areas. This finding is supported by Hasni et al. (2024), who explained that at lower densities, individuals have more space to forage and grow. In contrast, at higher densities, competition for food and space becomes greater.

The condition observed in Sinaboi Beach is also consistent with the findings of Utami et al. (2024) at Ujung Pasir Beach, South Kalimantan, where manual harvesting intensity by coastal communities showed a negative correlation with the density of *Meretrix meretrix*. Areas that were frequently exploited exhibited lower abundance than areas that were rarely utilized. Further analysis in that study indicated that high harvesting pressure can alter population size structure, reflected by the reduced number of large individuals due to size-selective harvesting.

A similar phenomenon was reported by Sari et al. (2023) at Tegal Besar Beach, Central Java, who found that shellfish collection by local communities significantly affected bivalve abundance and community structure. Locations that were more accessible to the public had lower bivalve abundance than relatively protected reference sites, particularly in the middle and lower intertidal subzones, which serve as the primary harvesting grounds.

The comparison between the Sinaboi Beach study and other coastal areas highlights that community harvesting activities, especially during low tide, constitute an important factor limiting bivalve abundance in the intertidal zone. Although environmental characteristics such as substrate type, tidal dynamics, and physical water parameters continue to influence marine biota distribution, anthropogenic pressure through repeated resource extraction appears to contribute substantially to the observed differences in abundance among locations.

Based on the ANOVA test results, the p-value obtained was 0.633 ($p > 0.05$), indicating that there was no significant difference in the abundance of *A. antiquata* among subzones. This value suggests that the observed differences in abundance across subzones fall within the range of natural variation and are not strong enough to demonstrate a significant effect of subzone differences on the distribution pattern of this species.

The absence of significant differences in *A. antiquata* abundance among subzones indicates that environmental conditions within each subzone are relatively uniform or remain within the species' ecological tolerance limits. Furthermore, the relatively even distribution of *A. antiquata* across subzones is likely associated with similar food resource availability and comparable substrate characteristics at the study site.

Distribution Pattern of *A. antiquata*

The distribution pattern of *A. antiquata* in the intertidal zone of Sinaboi coastal waters for each subzone is presented in Table 3.

Table 3. Distribution Pattern of Blood Cockle (*A. antiquata*)

Subzone	Id	Criteria
Lower	1,00	Random
Middle	0,95	uniform
Upper	1,08	clumped

Based on the research results, the calculated distribution pattern among subzones shows varying values, suggesting random, uniform, and clumped distributions. In the lower subzone, the Morisita index was 1.00, indicating a random distribution. Random distribution generally occurs when environmental conditions are highly uniform, and there is no strong tendency for individuals to aggregate. Such a pattern may develop when the habitat is homogeneous, and the organisms do not exhibit grouping behavior (Ode, 2017).

In the middle subzone, the index value was 0.95, indicating a uniform distribution pattern. Food availability is one factor that can lead to a uniform distribution of bivalves. When food resources are relatively evenly distributed within the habitat, individuals tend to spread out more evenly. This finding is consistent with Suhendra et al. (2017), who stated that uniform distribution in clams is driven by competition for space and food among individuals. Similarly, Purnama et al. (2019) explained that uniform patterns arise from spatial competition, which naturally promotes an even partitioning of ecological space.

Meanwhile, a clumped distribution pattern reflects habitat suitability for mollusks. According to Supratman & Syamsudin (2018), clumped distribution may occur in areas that provide favorable conditions for shelter and feeding, as well as due to interactions between male and female individuals during reproductive processes. The distribution of an organism is influenced not only by environmental factors but also by the organism's biological characteristics. A clumped distribution pattern is strongly determined by the average density recorded during sampling (Prasojo et al., 2012).

Shell Size Distribution of *A. antiquata*

A total of 80 individuals of blood cockle were measured in the intertidal zone of Sinaboi coastal waters. In this study, the shell size of *A. antiquata* was classified into three size classes: Class I (≤31.19 mm), Class II (31.20–44.29 mm), and Class III (≥44.30 mm). The measurement results showed that the most abundant individuals belonged to Class I (≤31.19 mm), with the highest number found in the lower subzone. Most cockles from Sinaboi waters were categorized as small to medium in size. The shell size distribution of *A. antiquata* in the intertidal zone of Sinaboi coastal waters for each subzone is presented in Figure 3.

The high number of individuals within the mid-size range indicates that the population is largely in a developmental stage. Meanwhile, the relatively low number of larger individuals is presumed to result from natural mortality or harvesting pressure. According to Zakaria et al. (2019), when young individuals dominate a population, the number of adult organisms tends to decline markedly, possibly due to natural mortality or environmental factors.

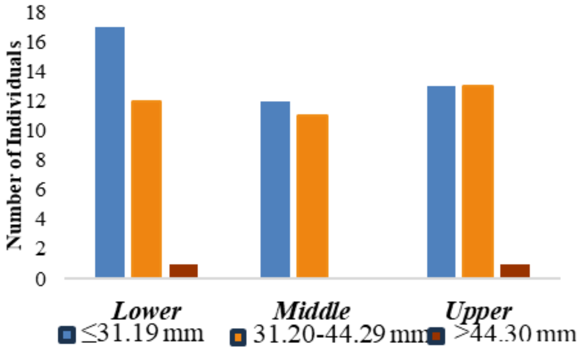

Figure 3. Shell Size Distribution of Blood Cockle (*A. antiquata*)

In this study, only two large-sized individuals were recorded. This condition is likely related to harvesting behavior, as fishers generally collect larger cockles first because they contain more meat and have a higher market value

4. CONCLUSION

Based on the study conducted in the intertidal zone of Sinaboi coastal waters, it can be concluded that the blood cockle showed the highest abundance in the lower subzone. In contrast, the lowest abundance was observed in the middle subzone. The distribution pattern of *A. antiquata* varied among subzones: the lower subzone tended to show a random pattern, the middle subzone showed a uniform pattern, and the upper subzone exhibited a clumped pattern. The shell size of *A. antiquata* recorded in this study ranged from 18.1 to 57.4 mm, with the size distribution dominated by small and medium individuals.

REFERENCES

Abdillah, B., & Karnan, S.D. (2019). Struktur Komunitas Mollusca (Gastropoda dan Bivalvia) pada Daerah Intertidal di Perairan Pesisir Poton Bako Lombok Timur Sebagai Sumber Belajar Biologi. *Jurnal Pijar MIPA*, 14(1): 208–216.

Abdullah, A., Nurjanah, N., Hidayat, T., & Yusefi, V. (2013). Profil Asam Amino dan Asam Lemak Kerang Bulu (*Anadara antiquata*). *Jurnal Pengolahan Hasil Perikanan Indonesia*,16(2): 159-167.

Abdurrahman, M., Tanjung, A., & Yoswaty, D. (2017). Kelimpahan dan Sebaran Kerang Darah (*Anadara Granosa*) di Zona Intertidal Ekosistem Mangrove Monospesies *Avicennia alba* di Desa Anak Setatah Kabupaten Kepulauan Meranti Provinsi Riau. *JOM FAPERIKA*, 4(2): 11-18.

Brower, J.E., Zar, J.H., & Ende, C.N.V. (1989). *Field and Laboratory Method for General Ecology 4th Edition*. McGraw-Hill Publication. Boston, USA. 23 p.

Bua, A.T. (2017). Struktur Komunitas Bivalvia di Pantai Juata Laut, Tarakan, Kalimantan Utara. *Jurnal Biota*, *2*(1): 29-36.

Hasni, H., & Ketjulan, R. (2024). Kepadatan Kerang Bulu (*Anadara antiquata*) di Desa Sandi Kecamatan Kaledupa Selatan Kabupaten Wakatobi. *Jurnal Manajemen Sumber Daya Perairan*, *1*(4): 49-61.

Noris, M. (2021). Makrozoobhentos di Pesisir Pantai Kalaki Kec. Palibelo Kab. Bima Nusa Tenggara Barat. *Bioedukasi*: *Jurnal Pendidikan Biologi*, 13(2): 86-91.

Mucha, A.P., Vasconcelos, M.T.S., & Bordalo, A.A. (2003). Macrobenthic Community in the Douro Estuary: Relations with Trace Metals and Natural Sediment Characteristics. *Environmental Pollution*, 121(2): 169-180.

Ode, I. (2017). Kepadatan dan Pola Distribusi Kerang Kima (*Tridacnidae*) di Perairan Teluk Nitanghahai Desa Morella Maluku Tengah. *Agrikan: Jurnal Agribisnis Perikanan*, 10(2): 1-6.

Odum, E. P. (1993). *Dasar-dasar Ekologi*. Gramedia, Jakarta, 697 p.

Prasojo, S.A., Irwani, I. & Suryono, C.A. (2012). Distribusi dan Kelas Ukuran Panjang Kerang Darah (*Anadara granosa*) di perairan Pesisir Kecamatan Genuk, Kota Semarang. *Journal of Marine Research*, 1(1): 137-145.

Purnama, M.F., Abdullah, A., Admaja, A.K., & Afu, L.O.A. (2019). Population Density and Distribution Patterns of Kalambodo Mussel (*Anodonta woodiana*) in the Sub Watershed of

Lahombuti River, Lahotutu Village, Konawe District South East Sulawesi. *Aquasains*, *8*(1): 759-768.

Samson, E., & Kasale, D. (2020). Keanekaragaman dan Kelimpahan Bivalvia di perairan Pantai Waemulang Kabupaten Buru Selatan. *Jurnal Biologi Tropis*, 20(1): 78-86.

Sari, P.N., Kristanto, A., & Yuliana, D. (2023). Dampak Kegiatan Pengambilan Kerang terhadap Komunitas Bivalvia di Pantai Tegal Besar, Jawa Tengah. *Jurnal Biologi Pesisir*, 8(2): 83–95.

Suhendra, I., & Bahtiar, D.O. (2017). Studi Distribusi dan Kepadatan Kerang Pasir (*Modiolus modulaides*) di Perairan Pulau Bungkutoko Kecamatan Abeli Kota Kendari Sulawesi Tenggara. *Jurnal Manajemen Sumber Daya Perairan*, 3(2): 179–187.

Supratman, O., & Syamsudin, T.S. (2018). Pola Distribusi dan Struktur Komunitas Moluska pada Ekosistem Intertidal. *Jurnal Ilmu dan Teknologi Kelautan Tropis*, 10(2): 357–366.

Utami, R., Mahesa, R., & Widodo, S. (2024). Pengaruh Intensitas Penangkapan terhadap Kepadatan *Meretrix meretrix* di Pantai Ujung Pasir, Kalimantan Selatan. *Jurnal Sumberdaya Pesisir*, 12(1): 45–58.

Zakaria, M.H., Agustono, A., Dewi, N.N., & Pursetyo, P.K. (2019). Hubungan Panjang Berat, Faktor Kondisi dan Nisbah Kelamin Kerang Bulu (*Anadara antiquata*) di perairan Sedati, Sidoarjo, Jawa Timur. *Journal of Marine and Coastal Science*, 8(1): 1-13